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Jonghun Jung
KAIST, jjh7545@business.kaist.ac.kr

Byungtae Lee
KAIST, btlee@business.kaist.ac.kr

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Jonghun Jung, Graduate School of Management, KAIST, Seoul, jjh7545@business.kaist.ac.kr

Byungtae Lee, Graduate School of Management, KAIST, Seoul, btlee@business.kaist.ac.kr

Abstract

In financial service industry, firm's dependency on IT to deliver quality services has increased recent years. This study empirically examines the linkage between service dimensions of which quality depend on IT, and competitive advantage of firms. Consistent with the resource based theory, our result suggests that valuable, rare, and costly to imitate service dimensions make competitive advantage and induce better financial performance while other dimensions which are easy to imitate cannot be a source of competitive advantage. Additionally, we show the competitive advantage derived from the complementary relationship among service dimensions. The existence of complementary relationships among service dimensions is verified. This implies that, even though some dimension cannot be a source of competitive advantage alone, these are still relevant to total service quality management for financial performance.

Keywords: IT service, complementarity, service quality management

1 INTRODUCTION

During the past decades, customer service has emerged as a strategic imperative for many firms (Reichheld and Sasser 1990;Rust et al. 1995). Especially, online services have grown rapidly and have emerged as the leading edge of the service industry (Yang and Fang 2004). Also service quality has been the subject of considerable interest among marketing academics and practitioners, spurred by the original work of Parasuraman et al.(1985). In previous studies, it was shown that service quality increases customer satisfaction (Krishnan 1999; Bowen and Hedge, 1993) and that such an increase in turn improved the financial performance via enhanced customer loyalty (Anderson et al,1994; Heskett et al.1997;Hallowell 1996). Among ecommerce applications, online brokerage is identified as one of the best candidates to be fully explored and implemented (Koch and Cebula 2002) as a “killer application” in the B2C ecommerce world (Chen and Hitt 2002). For example, by the end of 2006, the proportion of online trading reached about 80% of the total accounts in Taiwan (Shim et al. 2008). In Korea, the proportion of online transactions takes more than half of the total revenue. The Korean brokerage service firm data show that the revenue of a firm increases exponentially as its service quality increases. Therefore management of service quality could be considered critical for financial performance.

Service has multi-dimensions. Previous marketing and service related papers have investigated the multi-dimensionality of service quality (Parasuraman et al. 1988;Brown et al.1993; Fisk et al. 1993) in the online service industry (Shankar et al. 2003; Yang and Fang 2004). Their main focuses were identify service attributes that enhance customer satisfaction in various contexts (Pitt et al.1995; Yang et al. 2003; Zeithmal et al. 2001; Shankar et al. 2003; Santos 2003) or to investigate the asymmetric and dynamic effect of service quality on customer satisfaction (Cheung and Lee 2005; Anderson et al. 2005; Falk et al. 2010). However, main topics of prior studies were mostly limited to the effects of service quality on customer satisfaction. That is, they treated service as a single unit while other studies have identified the multi-dimensionality of service. To the best of our knowledge, empirical studies on the link between service quality dimensions and competitive advantage are rare. This study tries to fill such void. In investigating differential impacts of service dimensions, we employ resource-based theory (Barney 1991; Rumelt 1984; Wernerfelt 1994), and empirically test our hypotheses using data from the online security brokerage service in Korea. Consistent with the resource based theory, our result suggests that service dimensions which are valuable, rare, and costly to imitate provide a competitive advantage and induce a better financial performance while other dimensions which are easy to imitate cannot be a source of competitive advantage. Additionally, we show the competitive advantage derived from the complementary relationship among service dimensions. The existence of complementary relationships among service dimensions is verified.

Additionally, service quality dimensions are not independent but related with each other. Therefore, we also investigate the competitive advantage derived from such relationships among service dimensions. In the resource based theory, compared to synergies arising from the relatedness of resources, synergies arising from complementarity of resources are much more difficult to be observed and to be imitated (Tanriverdi and Venkatraman, 2005). Also, due to the complementarities implementation failure in one dimension will negatively affect the implementation of other dimensions, leading to the failure of the entire imitation effort (Milgrom and Roberts 1995). Although previous studies investigate various service quality dimensions, linkages between service quality dimensions and competitive advantage are not fully explored, especially in IT service areas. Our result shows the existence of complementary relationship among IT service quality dimensions.

2 THEORETICAL BASES

2.1 Service quality and financial performance

In the past decade, researchers have found evidences of the positive impact that service quality has on profit and other financial outcomes of a given firm (Greising,1994; Rust et al. 1995). Parasuraman et al.(1988) found a positive and significant relationship between customer perceptions of service quality and (1) their willingness to recommend the company, and (2) their purchase intentions. Boulding et al.(1992,1993) also showed a positive correlation between service quality and outcome variables such as repurchase intentions and willingness to recommend. Reichheld and Sasser(1990) argued that reducing defects leads to greater loyalty, and increased loyalty leads, in turn, to greater productivity via lower costs of making future transactions, favorable word of mouths, and perhaps even a price premium. Koska(1990) and Nelson et al.(1992) also presented a positive relationship between patient satisfaction and hospital profitability. Consequently, customer satisfaction is related to customer loyalty, which in turn is related to profitability (Heskett et al.1997; Roger,1996).

It has been observed that financial service firms often lose customers due to poor service rather than poor products (Bowen and Hedge, 1993). Despite the relative importance of IT to service quality, especially in the financial service industry, empirical studies are still limited in this area (Wang et al.1999). While there are significant similarities across groups, the impact of loyalty on overall customer satisfaction was higher in the online group than others (Shankar et al. 2003). The online brokerages have transformed trading from a professional activity to a commoditized online activity. Due to the importance of private investors, the necessity to satisfy their needs in online trading systems has increased (Weinhabart et al.1999; Zeithmal 2000).

2.2 Multi-dimensions of service quality

Multi-dimensionality in service quality has been intensively studied. An exploratory study by Parasuraman et al. (1985) elicited ten dimensions. Parasuraman et al. (1988) further reduced these ten dimensions to five. Based on the five quality attributes, they developed a global measurement for service quality (SERVQUAL). SERVQUAL has been applied to numerous service industries which triggered some criticism and considerable debates in the marketing area (Parasuraman et al 1993, Fisk et al. 1993). Pitt et al.(1995) validated the appropriateness of SERVQUAL to assess IS service quality.
Objectives of previous studies were limited to identifying relevant service attributes that contributed to customer satisfaction. Yang and Fang (2004) uncovered that the primary service quality dimensions that lead to online customer satisfaction, with the exception of ease of use, are closely related to traditional services, while key factors that lead to dissatisfaction are tied to information system quality. Also, from content analysis, they uncovered 16 dimensions and 52 related items that are related with the role of online service companies which is assisting clients to choose the right products. These firms conduct this by providing adequate and timely information; speedy and accurate completion of a transaction; and satisfactory resolution of any problems incurred. Once this preliminary activity is satisfied, full-fledged improvement efforts can be initiated. They established a conceptual framework by integrating two major aspects of online services: customer service quality and information system quality. In an online setting, many conventional service quality dimensions become less relevant. Based upon six focus group interviews, 13 e-service quality dimensions were identified (Zeithmal et al. 2000). Santos(2003) also developed a conceptual model of the determinants of e-service quality.

The idea of symmetric effects is challenged by the model of Kano (1984) that identifies three types of quality attributes (1) basic attribute, (2) performance attribute, and (3) excitement attribute. Cheung and Lee(2005) identified the positive and negative asymmetric effects that a given website attributes performance does have on customer satisfaction. Falk et al.(2010) argued that as the customer relationship matures, functional utilitarian quality attributes lose their capability to delight customers, Also hedonic quality attributes only showed an enhancing effect on satisfaction for more experienced customers.

2.3 The resource based view, competitive advantage and complementarity

Resource-based theory explains the conditions under which firms are able to make and sustain a competitive advantage (Amit and Schoemaker 1993; Barney 1986,1991; Rumelt 1984;Wernerfelt 1984). Differences in performance are explained by the types of resource and capabilities that firms control. The value, rarity, and imitability of these resources have been shown to be a source of competitive advantage (Barney 1991). In the IT context, studies have figured out various IT related resources that contribute to a competitive advantage. Mata et al.(1995) argues that since managerial IT skills are rare and firm specific they are likely to serve as a source of competitive advantage.

Compared to synergies arising from the relatedness of resources, synergies arising from the complementarity of resource are much more difficult to observe and imitate(Tanriverdi and Venkatraman.2005). Additionally, due to the complementarities, implementation failure in one dimension will negatively affect the implementation of other dimensions, leading to the failure of the entire imitation effort(Milgrom and Robert.1995).

Complementary relationship is generally used in various contexts with some variant meanings. In economics, this relationship exists in a case when the price of one goods increases, the demand of other goods becomes less (Allan et al. 2004). In the production function, it is generally used as the opposite concept of substitution. Leontief production function states that inputs are always strictly complements in the creation of a product (Goldin and Katz 1996). When there is a production function comprised of two inputs, it is complement that two inputs are always concurrently needed to produce something. Krusell et al. (2000) argues that technology is acapital-skill complementarity. This means that the elasticity of substitution between capital equipment and unskilled labor is higher than that between capital equipment and skilled labor. Hence, growth in the stock of equipment increases the marginal product of skilled labor, but decreases the marginal product of unskilled labor. Griliches(1969) tested whether physical capital and human capital are complements to each other. In strategy research, it means that one resource leverages the effect of others (Tafti et al. 2007). Theoretical arguments from previous literature, as well as some practical or anecdotal examples, support the idea that HR and IT practices can be complementary to each other. Milgrom and Roberts(1995), Baker et al.(1994), and Holmstrom and Milgram(1994) developed some of the analytical underpinning of strategic complementarities. Among empirical studies on the relationship between IT and HR, Breshnan et al.(2002) discovered that IT investment accompanied by work reorganization investment and a more highly skilled workforce altogether contribute to firm-level productivity. Powell and Dent-Micallef(1997) examined the relationship between IT and HR practices, taking the perspective that IT is a technological resource that leverages other firm resources.

3 HYPOTHESES

Firms can have better financial performances by providing better and multiple dimensional service quality. But, due to scarcity of resources, firms may not be able to provide superior service quality in all dimensions. With such limited resources, managers may attempt to allocate resources among dimensions by selecting those that have higher impacts on the competitive advantage of their firm. Falk et al. (2010) shows that functional-utilitarian quality attributes eventually lose their capability to delight customers as the customer relationship matures. In a brokerage service system, functional-utilitarian service dimension stand for basic functions of the brokerage system that serve by fulfilling customer requests rapid and safe. Yang and Fang (2004) show that in online securities brokerage services, information system service quality is tied not to satisfaction but to dissatisfaction. In an online security brokerage service, increasing the service quality of these dimensions does not improve the competitive advantage. We refer to these dimensions as 'system functional dimensions'. In resource based theory, value, rarity, and imitability of resources have been shown to be relevant characteristics for a competitive advantage (Barney 1991). Resource-based theory suggests that even resources that are held by only a few competing firms, will rapidly diffuse among competitors if they are also not costly to imitate. Even A resource that is valuable and rare, it cannot become a source of competitive advantage if it is easy to imitate . In an online security brokerage service, the service quality of a 'system-functional dimension' is determined by the quality of the IT system and is easy to imitate by IT investment. In a mature brokerage system, the service quality of this dimension is converged to a similar level due to easiness of imitation and inability to make a difference in customer satisfaction and financial performance.

H1. Service quality of 'system-functional dimension', per se, will not explain variance in the financial performance across firms.

Falk et al. (2010) argues that hedonic quality attributes only exhibit an increasing effect on satisfaction for more experienced customers. Yang and Fang (2004) reveal that major drivers of online service satisfaction are strongly tied to traditional service quality dimensions rather than IT service dimensions. Therefore improvement of a financial performance is possible by increasing the service quality of these traditional dimensions. In the service industry, the service quality of several dimensions are determined not only by the amount of IT investment but also by non-IT factors which are different for each firm. Therefore firms are unable to easily imitate service quality of these dimensions and such dimensions can be a source of competitive advantage. We refer to these dimensions as 'strategic dimensions'.

H2.Service quality of 'strategic dimension', per se, will explain variance in the financial performance across firms.

Given the differential impact on competitive advantages among service dimensions, brokerage firms may have to determine which dimensions they invest in and what level of service quality they should provide. Firms try to gain a competitive advantage through investments with limited resources and face the selection of two alternative choices; (1) concentrate on a certain kind of service dimension and provide a specified superior service or (2) invest in various dimensions on a somewhat evenly level. In this choice, based on RBV, firms may concentrate on a certain service dimension and this is consistent with the general belief of management: 'choice and focus'. However, service quality dimensions are not independent but related with each other.
Therefore, complementarity between service dimensions can be a source of competitive advantage. If complementarity between service dimensions exists, it would be a more beneficial decision to invest in various service dimensions evenly rather than to concentrate on a certain kind of service dimensions. Therefore, Figuring out the existence of complement relationships between service quality dimensions is important in terms of total service quality management which effects the financial performance.

H3. Service dimensions are complementary in their contribution to firm's financial performance

In this paper, we focus on the concept of complementarity that is mainly used in context of management literatures. It means that resources leverage each other.

4 EMPIRICAL TEST

4.1 Data

In the previous paper, Ray et al.(2005) choose the insurance industry for three reason; digitalization of the industry, importance of the customer, and high variance between firms' abilities. The online security brokerage service has very similar characteristics and is therefore proper to be selected for an investigation in this paper. First, the financial service industry, due to the digitalized nature of its products and services, has been one of the largest investor in IT(Ray et al. 2005). IT became a crucial tool by providing customer services the information they require in order to deliver quality service(Elam and

Morrison 1993). Moreover, the online security brokerage area is even more proper than the insurance industry because security and its trading systems are totally digitalized. Second, in a highly competitive market, customer service became more and more strategically important(Berry 1995; Griffith 1993). Third, there exist a high level of variance between the abilities of firms in the online security brokerage service, a fact that suggests that firms differ in their ability to provide service quality.

The growth of online trading is a worldwide trend, including the most IT-developed Asia-Pacific countries. Since the deregulation of online trading in 1997, the volume of online trading has increased dramatically in Korea. Our data consists of data from 17 online brokerage firms, which spans over a period of seven years from 2001 to 2009, hence the total sample size is 153 and the data form is a balanced panel. In the case of our study, the extremely high penetration of online trading in Korea shows that online brokerage services have reached a mature stage(Shim et al. 2008). We have two data sources for two major variables: profit of online brokerage, and the quality of services. The profit data is from the DART (Data Analysis, Retrieval and Transfer System) database (http://dart.fss.or.kr). DART is an electronic system that allows companies to submit disclosures online. From this public site, we retrieved the financial statements of security firms and found online brokerage commission data. We obtained system quality data from Stockpia.com, a leading rating agency for the finance sector. Similar to Forrester.com or Gomez Advisors, Stockpia.com provides expert ratings of online brokerage services. It has appraised the quality of the online brokerage system in various dimensions, and has released and scored then on a quarterly basis since 2000. The appraisers are composed of academicians in related areas and internal firm experts. Shim et al. (2008) used this data set for investigation of the dynamic effect of service quality and price.

Stockpia.com adopts five sub constructs for quality measurement of online brokerage systems:

1) System speed and stability. System speed is measured by examining the screen loading time for information menus and real transaction time for trading menus, while system stability is measured by the frequency of response delays or failures. 2)trading functionality, which considers general trading convenience as well as the variety of functions and menus for online stock, option, and futures trading, 3) information provision, which measures the quality of information on the market such as charts, investment guides, and various research reports, 4) communication channels, which evaluates the quality of communities or education tools for advising on customers investment decisions(e.g. financial product selection, stock investment), 5)finally, customer support, which examine the quality of help menus, personalization services and, privacy protection

For the empirical test of service dimensions, we classify five service dimensions of Stockpia as two groups based on factor analysis. By factor analysis, five dimensions are classified as two factors.

	factor	
# of factors	1	2
Trading	0.980	0.083
Information	0.945	0.116
Support	0.918	-0.144
Communication	0.904	-0.303
speed	-0.033	0.990

Table 1. Factor analysis

Based on the attributes that influence on service quality and factor analysis, we classify service quality dimensions as two groups.

Stockpia dimensions		Sub contents	Trait
System functional dimension	Stability	Examining the screen loading time, Real transaction time, Frequency of response delay or failure	Easy to imitate
Strategic dimension	Trading	General trading convenience, Online menus	Difficult to imitate
	Information	Quality of information on the market, Investment guide, Research reports	Difficult to imitate
	Communication	Quality of community, Education tool for advising on customers investment decision	Difficult to imitate
	Supporting	Quality of help menus, Personalization services,	Difficult to imitate

Table 2. Categorization of service dimensions

We use the firm size as control variable in the tests. The literatures in IT management argue that the firm size is an important factor for management of IT project and system. At the organization level, large organizations are more likely to adopt innovations and advanced solutions compared to smaller organizations(Iacovou et al. 1995; Rogers,1995). Also, two factors limit the ability of small firms to invest in and use new IT: organizational readiness and perceived benefits(Dewan et al. 2005). Firm size is measured by using the total assets of firms.

4.2 Data analysis

We classify five service dimensions as two groups based on the factor analysis and make new integrating independent variables. In the system functional dimension, because only one service quality dimension- 'speed and stability' is classified as one factor, service quality of this dimension can be considered as the 'system functional dimension' itself. In the strategic dimension, because four service quality dimensions are classified as the same factor, we integrate these four variables and create a new independent variable. In this test, service quality of strategic dimension means the average of four service dimensions. Random effect model was used to test the hypotheses. Regression equation is as follows

Model 1: $\mathbf{Brokeragecommission} = \mathbf{Systemfunctional} + \mathbf{Strategic} + \mathbf{asset} + \sum$

Table3 shows the results of the regression analysis.

Variables	Brokerage commission
System functional dimension	380.0347 (0.37)
Strategic dimension	3774.046* (6.53)
Asset	0.0358438* (11.73)
R^2	0.6725

* p<0.05

Table 3. Results of panel analysis

Model 1 tests the direct effects of each service dimension's service quality on brokerage commissions(hypothesis 1 and 2). Consistent with hypotheses1, service quality of 'system-functional dimension' did not explain significant difference of financial performance. Consistent with hypothesis2, effect of service quality of 'strategic dimension' on financial performance is positive and significant. Hypotheses1and 2, therefore, are supported by empirical test. Overall, 'system-functional dimension' cannot be a source of competitive advantage and explain the variance of financial performance. Otherwise, 'strategic dimension' is a source of competitive advantage and explain the difference of financial performance.

Complementary relationship between service quality dimensions is tested with moderated regression analysis. In general terms, a moderator is a qualitative or quantitative variable that affects the direction and/or strengthen of the relation between an independent or predictor variable and a dependent or criterion variable. Specifically within a correlational analysis framework, a moderator is a third variable that affects the zero-order correlation between two other variables. In the more familiar analysis of variance(ANOVA)terms, a basic moderator effect can be represented as an interaction between a focal independent variable and a factor that specifies the appropriate condition for its operation(Baron and Kenny 1986) The complementary can be tested by regression with interaction term of independent variables(Tafti et al. 2009). The objective of this test is verified the significance of complementarity between service dimensions. In this test, our concern is significance of interaction term. Even though high correlation between service dimensions can cause multicollinearity, this problem makes test more conservative and is apt to reject significant variable by increasing of variance. Also interaction term between service dimensions has low correlation with each service quality dimension and do not cause multicollinearity. Then, we construct test model as follows

Model 2: $brokeragecommission = D1(trading) + D2(information) + D3(communication) + D4(supporting) + D5(speed) + asset + \sum$

Model 3: $brokeragecommission = D1(trading) + D2(information) + D3(communication) + D4(supporting) + D5(speed) + Di * Dj + asset + \sum$

The results of test as follows

variables	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission	brokerage commission
D1 (trading)	0.2000123 -2.62	0.2151344 2.86	0.2217481 2.92	0.2194737 2.94	0.2041625 2.64	0.202102 2.65	0.185672 2.48	0.2041977 2.67	0.2100514 2.74	0.2107041 2.68	0.2054001 2.64
D2 (information)	0.1136894 1.26	0.1898808 2.03	0.1201613 1.34	0.1174762 1.33	0.1156759 1.27	0.1730412 1.87	0.17906 1.97	0.1169725 1.29	0.1112773 1.22	0.1166374 1.25	0.1186354 1.29
D3 (communication)	-0.0354721 -0.54	-0.0328274 -0.51	-0.0150093 -0.23	-0.0183821 -0.29	-0.036548 -0.55	-0.0144789 -0.22	-0.0301321 -0.47	-0.042205 -0.64	-0.0124137 -0.19	-0.0332175 -0.49	-0.0341064 -0.51
D4 (supporting)	0.1006025 1.34	0.0700317 0.93	0.0968047 1.3	0.1209257 1.64	0.1035483 1.37	0.1009416 1.34	0.1305524 1.76	0.1033937 1.37	0.1397672 1.8	0.1152666 1.48	0.1080579 1.41
D5 (speed)	-0.0377987 -1.41	-0.0368254 -1.39	-0.0340855 -1.28	-0.0374938 -1.43	-0.0397025 -1.44	-0.0285175 -1.05	-0.033332 -1.26	-0.0416985 -1.52	-0.0351233 -1.3	-0.0398672 -1.41	-0.0388841 -1.4
asset	5.42E-08 4.06	5.90E-08 4.45	5.46E-08 4.13	5.49E-08 4.22	5.46E-08 4.05	5.88E-08 4.4	5.90E-08 4.49	5.42E-08 4.05	5.55E-08 4.14	5.66E-08 4.1	5.62E-08 4.12
D1*D2		0.1124038* 2.62									
D1*D3			0.0984156* 2.13								
D1*D4				0.1197622* 2.82							
D1*D5					0.0130111* 2.44						
D2*D3						0.1084718* 2.42					
D2*D4							0.1275539* 3.08				
D2*D5								-0.0226459 -0.78			
D3*D4									0.0879822* 1.96		
D3*D5										-0.025583 -0.88	
D4*D5											-0.0175422 -0.62
R^2	0.6159	0.7229	0.7044	0.7189	0.6141	0.7158	0.7265	0.6122	0.6915	0.6139	0.6149

* $p<0.05$

Table 4. Results of complementarity test

Hypothesis 3 suggested that service dimensions would interact each other to explain variance in financial performance. Ten pairwise test results show that service dimensions complement each other.
Above results can be shown briefly in table 5.

	D1	D2	D3	D4
D2	O	-	-	-
D3	O	O	-	-
D4	O	O	O	-
D5	O	X	X	X

Table 5. Complementarity between dimensions

Service dimension of D1(trading) is complement with D2(information), D3(communication), and D4 (supporting), D5(speed). Also D2(information) complement with D3(communication) and D4(communication). And D3(communication) complement with D4(supporting). Even though 'system functional dimension', D5(speed), does not influences financial performance alone, it moderates the influence of D1(trading).

In test model 1, service quality of stability dimension does not have influences on difference of financial performance alone because it is system-functional dimension and easy to imitate. However, stability has complement relationship with information and supporting. It means that although it does not direct influence financial performance alone, it is still important in terms of compelementarity. Additionally, service qualities of 'strategic dimension' are complement each other.

5 CONCLUSION

Managers have to understand different characteristics of service quality dimensions and consider complementary relationships to manage the total service quality effectively with restricted resources. Although many previous papers have investigated the multi-dimensions of service quality, previous papers mainly focused on customer satisfaction. However, it is important to understand the characteristic of each service quality dimension and to figure out dimensions which can induce competitive advantage for financial performance. Empirical researches that examine the link between various traits of service quality dimensions and competitive advantage have been lacking. This paper fills this lack by drawing on resource-based theory to investigate the differential effects of service dimensions on the financial performance. Consistent with resource based theory, the result suggests that valuable, rare, and costly to imitate service dimensions contribute to the competitive advantage and induce better financial performance. And a service dimension which is easy to imitate cannot be a source of competitive advantage. Additionally, service dimensions are not independent but related to each other. And we investigate the competitive advantage derived from the complement relationship between service dimensions. Although previous studies investigate various service quality dimensions, there is no paper that is concerned about the relationship of service dimensions and competitive advantage. Result shows the existence of complement relationship between service dimensions.

Some dimensions, which are easy to imitate and cannot make any difference of the financial performance, moderate other service dimensions. It means that, even though some dimensions cannot be a source of competitive advantage alone, these dimensions are still important in terms of total service quality management for financial performance. This is a beginning paper that investigates the effect of multi-dimensions of service quality and relationship among dimensions on competitive advantage based on resource-based theory.

6 LIMITATIONS AND FUTURE RESEARCH

In this paper, we investigate the complementarity among five service dimensions. Although we figure out existence of complement relationship between two service dimensions, the interpretation of complementarity is not clear. Therefore more concrete study about relationship between service dimensions is needed.

Adding interaction term and investigating the difference of coefficient are generally used to test the existence of complement of two independent variables. But, in this paper, service quality consists of five dimensions and independent variables are five. Because some service quality dimensions have high correlation, multicollinearity problems may occur. Even though, in this test, mulitycollinearity is not a crucial problem that induces erroneous results and interaction terms escaped from the multicollinearity problem, a more rigorous test model could be beneficial.

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